SAMPLE QUESTION PAPER - 2025-26
CLASS XII - MATHEMATICS (041)

Time Allowed: 3 Hours **Maximum Marks: 80**

General Instructions:

1. This Question Paper contains **38** questions. All questions are compulsory.
2. The question paper is divided into FIVE Sections – A, B, C, D and E.
3. Section **A** comprises of **20** questions of **1** mark each.
4. Section **B** comprises of **5** questions of **2** marks each.
5. Section **C** comprises of **6** questions of **3** marks each.
6. Section **D** comprises of **4** questions of **5** marks each.
7. Section **E** comprises of **3** Case Study Based Questions of **4** marks each.
8. There is no overall choice in the question paper. However, an internal choice has been provided in **2** questions in Section B, **3** questions in Section C, **2** questions in Section D and **2** questions in Section E (in the sub-parts).
9. Use of calculators is **not** permitted.

SECTION A (20 Marks)

This section comprises **20** *questions of* **1** *mark each. Questions 1-18 are Multiple Choice Questions (MCQs) and questions 19-20 are Assertion-Reason based questions.*

Multiple Choice Questions (MCQs)

1. Let R be a relation on the set $\mathbb{N}$ of natural numbers defined by xRy if x divides y. Then R is:
   - (a) Reflexive and Symmetric
   - (b) Transitive but not Symmetric
   - (c) Reflexive and Transitive
   - (d) An Equivalence relation
2. If $\cos\left(\sin^{-1}\left(\frac{1}{2}\right)+\cos^{-1}\left(\frac{1}{2}\right)\right)$ is equal to:
   - (a) 0
   - (b) 1
   - (c) $\frac{1}{2}$
   - (d) $\frac{\sqrt{3}}{2}$
3. If $f:\mathbb{R}\to\mathbb{R}$ is defined by $f(x)=3x-2$, then $f^{-1}(x)$ is:
   - (a) $3x+2$
   - (b) $\frac{x}{3}-2$
   - (c) $\frac{x+2}{3}$
   - (d) $\frac{x-2}{3}$
4. The principal value of $\tan^{-1}\left(-\sqrt{3}\right)$ is:
   - (a) $\frac{2\pi}{3}$
   - (b) $-\frac{\pi}{6}$
   - (c) $-\frac{\pi}{3}$
   - (d) $\frac{\pi}{3}$

5. Let $A = \{1, 2, 3\}$. The number of equivalence relations containing $(1, 2)$ is:
   (a) 1
   (b) 2
   (c) 3
   (d) 4
6. If a matrix A is both symmetric and skew-symmetric, then A is a:
   (a) Diagonal matrix
   (b) Zero matrix
   (c) Square matrix
   (d) Identity matrix
7. If A is a square matrix of order 3 and $|A| = -2$, then $|adj(A)|$ is equal to:
   (a) 4
   (b) -2
   (c) -8
   (d) 2
8. If A is an invertible matrix of order 2, then $\det(A^{-1})$ is equal to:
   (a) $\det(A)$
   (b) $\frac{1}{\det(A)}$
   (c) 1
   (d) 0
9. The matrix $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ is the inverse of:
   (a) $\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$
   (b) $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$
   (c) $\begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$
   (d) $\begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix}$
10. The value of x for which $\begin{vmatrix} 3 & x \\ x & 1 \end{vmatrix} = \begin{vmatrix} 3 & 2 \\ 4 & 1 \end{vmatrix}$ is:
   (a) $2\sqrt{2}$
   (b) 4
   (c) $\pm 2\sqrt{2}$
   (d) ± 4
11. The value of $\int_{-1}^{1} (x^3 + x)\, dx$ is:
   (a) 2
   (b) 1
   (c) -1

(d) 0

12. If $y = \log(\sqrt{\sin x})$, then $\frac{dy}{dx}$ is:

(a) $\cot x$

(b) $\frac{1}{2}\cot x$

(c) $\frac{1}{\sqrt{\sin x}}$

(d) $\frac{\cos x}{\sqrt{\sin x}}$

13. The integrating factor of the differential equation $x\frac{dy}{dx} - y = 2x^2$ is:

(a) x

(b) $-x$

(c) $\frac{1}{x}$

(d) $-\frac{1}{x}$

14. The slope of the tangent to the curve $y = x^2 - 2x + 1$ at $x = 1$ is:

(a) 0

(b) 1

(c) 2

(d) -1

15. The order and degree of the differential equation $\left(\frac{d^3y}{dx^3}\right)^2 - 3\left(\frac{dy}{dx}\right)^2 + y = 0$ are:

(a) Order 3, Degree 2

(b) Order 3, Degree is not defined

(c) Order 2, Degree 3

(d) Order 1, Degree 2

16. The minimum value of the function $f(x) = x\log x$ is:

(a) $-\frac{1}{e}$

(b) e

(c) 1

(d) 0

17. The projection of the vector $\mathbf{a} = 2\hat{\imath} - \hat{\jmath} + \hat{k}$ on the vector $\mathbf{b} = \hat{\imath} + 2\hat{\jmath} + 2\hat{k}$ is:

(a) $\frac{2}{3}$

(b) $\frac{1}{3}$

(c) $\frac{2}{\sqrt{9}}$

(d) $\frac{1}{9}$

18. The length of the perpendicular from the origin to the plane $\mathbf{r} \cdot (3\hat{\imath} - 4\hat{\jmath} + 12\hat{k}) = 52$ is:

(a) 4 units

(b) 52 units

(c) 13 units

(d) 12 units

19. If $P(A) = 0.8$ and $P(B|A) = 0.5$, then $P(A \cap B)$ is:

(a) 0.4

(b) 0.3

(c) 0.25

(d) 0.5

Assertion-Reasoning Based Questions

Questions 19 and 20 are Assertion-Reasoning based questions. In these questions, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct answer from the following options:

(a) Both A and R are true and R is the correct explanation of A.

(b) Both A and R are true but R is not the correct explanation of A.

(c) A is true but R is false.

(d) A is false but R is true.

20. **Assertion (A):** The function $f(x) = |x - 1|$, $x \in \mathbb{R}$ is not differentiable at $x = 1$. **Reason (R):** A function is not differentiable at a point where the graph has a sharp corner or a cusp.

SECTION B (10 Marks)

This section comprises **5** *questions of* **2** *marks each.*

21. Find the value of k so that the function $f(x) = \begin{cases} \frac{\sin x}{x}, & \text{if } x < 0 \\ x^2 + k, & \text{if } x \geq 0 \end{cases}$ is continuous at $x = 0$.

22. If $\vec{a}$ is a unit vector and $(\vec{x} - \vec{a}) \cdot (\vec{x} + \vec{a}) = 8$, find $|\vec{x}|$.

OR

Find the direction cosines of the line passing through the points $P(2, 3, -1)$ and $Q(4, 5, 2)$.

23. Find $\int \frac{dx}{x^2 - 6x + 13}$.

OR

Evaluate $\int_0^{\frac{\pi}{2}} \sin^2 x \, dx$.

24. Construct a 2×2 matrix $A = [a_{ij}]$ whose elements are given by $a_{ij} = e^{2i+j}$.

25. A pair of dice is thrown. What is the probability that the sum of the numbers is 8 or more, if 4 appears on the first die?

SECTION C (18 Marks)

This section comprises **6** *questions of* **3** *marks each.*

26. Show that the function $f : \mathbb{R} \to \mathbb{R}$ defined by $f(x) = \frac{2x-1}{3}$, is invertible. Hence find f^{-1}.

27. Find the equation of the tangent to the curve $y = x^3 - x + 1$ at the point where the curve crosses the y-axis.

OR

The total revenue in Rupees received from the sale of x units of a product is given by $R(x) = 3x^2 + 36x + 5$. Find the marginal revenue when $x = 5$.

28. Solve the differential equation $e^x \tan y \, dx + (1 - e^x) \sec^2 y \, dy = 0$.

OR

Find the particular solution of the differential equation $\frac{dy}{dx} = 1 + x + y + xy$, given that $y = 0$ when $x = 1$.

29. Find the vector equation of the line passing through the point $(1, 2, -4)$ and parallel to the vector $2\hat{i} + 3\hat{j} - 5\hat{k}$. Also, find its Cartesian equation.

30. Using properties of determinants, prove that:

$$\begin{vmatrix} 1 & a & a^2 \\ 1 & b & b^2 \\ 1 & c & c^2 \end{vmatrix} = (a-b)(b-c)(c-a)$$

OR

If $A = \begin{bmatrix} 3 & 1 \\ -1 & 2 \end{bmatrix}$, show that $A^2 - 5A + 7I = 0$.

31. Determine the maximum value of $Z = 3x + 4y$ if the feasible region of a LPP (Linear Programming Problem) is given by $x + y \leq 4, x \geq 0, y \geq 0$.

SECTION D (20 Marks)

This section comprises **4** *questions of* **5** *marks each.*

33. Find the area of the region bounded by the parabola $y^2 = 4x$ and the line $x = 3$.

OR

Find the area of the region lying above the x-axis and included between the circle $x^2 + y^2 = 8x$ and the parabola $y^2 = 4x$.

34. Solve the following system of equations using matrix method:

$$\begin{aligned} x + y + z &= 6 \\ y + 3z &= 11 \\ x - 2y + z &= 0 \end{aligned}$$

35. Show that the height of the cylinder of maximum volume that can be inscribed in a sphere of radius R is $\frac{2R}{\sqrt{3}}$.

OR

Evaluate $\int_{\pi/6}^{\pi/3} \frac{\sin x + \cos x}{\sqrt{\sin 2x}}\, dx$.

36. Find the shortest distance between the lines $\frac{x-1}{2} = \frac{y-2}{3} = \frac{z-3}{4}$ and $\frac{x-2}{3} = \frac{y-4}{4} = \frac{z-5}{5}$.

SECTION E (12 Marks)

This section comprises **3** *case study based questions of* **4** *marks each.*

37. **Case Study 1: Navigation and Vector Algebra**

A ship is being guided by two lighthouses. Lighthouse A is located at $A(2, 4, 3)$ and Lighthouse B is located at $B(-1, 5, 8)$. The ship is currently positioned at the origin $O(0, 0, 0)$.

Based on the given information, answer the following questions:

(a) Find the position vector of Lighthouse B. (1 Mark)

(b) Find the vector $\vec{AB}$. (1 Mark)

(c) Calculate the scalar projection of vector $\vec{OB}$ on vector $\vec{OA}$. (2 Marks)

OR

(d) Find a vector perpendicular to both $\vec{OA}$ and $\vec{OB}$. (2 Marks)

38. **Case Study 2: Disease Testing and Bayes' Theorem**

In a city, 20% of the population are known to have a certain disease. A medical test has been developed to detect the disease. The test correctly diagnoses 90% of the people who have the disease (True Positive) and correctly identifies 80% of the people who do not have the disease (True Negative). A person is selected at random from the population and is given the test.

Based on the given information, answer the following questions:

(a) Find the probability that a person is correctly diagnosed by the test. (1 Mark)

(b) If the test result is positive, find the probability that the person actually has the disease. (3 Marks)

OR

(c) Find the probability that the person has the disease given the test result is negative. (3 Marks)

39. **Case Study 3: Rate of Change and Optimization**

A water tank has the shape of an inverted circular cone with a base radius of 4 meters and a height of 8 meters. Water is being poured into the tank at a constant rate of 2 m^3/min.

(Volume of a cone is $V = \frac{1}{3}\pi r^2 h$)

Based on the given information, answer the following questions:

(a) Express the radius r of the water surface in terms of its height h. (1 Mark)

(b) Find the rate at which the water level is rising ($\frac{dh}{dt}$) when the water depth (h) is 4 meters. (3 Marks)

OR

(c) If the rate of change of volume were $\frac{dV}{dt} = 2h$, find the rate of change of height ($\frac{dh}{dt}$) when $h = 4$ meters. (3 Marks)